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ABSTRACT

This document contains a set of 10 activities that teachers may use with students (ages 10 to adult) to enhance environmental knowledge and environmentally responsible behavior. Sample worksheets are included when applicable. The activities focus on: renewable and nonrenewable resources; recycling; population growth; wildlife; recycling in a cemetery; food in other lands; astronomy; population density; caves; use of mathematics to estimate the height of a silo and to study problems relevant to such environmental issues as food chains, food waste, water waste, and the cost of electricity; and use of a compass to determine azimuths or compass bearings. (JN)

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ENVIRONMENTAL EDUCATION ACTIVITIES TO ENHANCE DECISION-MAKING

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Guidelines for Teachers

Environmental education is a complex, interdisciplinary field of study ranging from physical science to biological science, from social science to ethics. Environmental discussions usually include ways to help students improve their immediate surroundings, such as the campaigns to stop littering and to turn off lights.

Our objective in preparing these materials is to present some basic concepts that you may use as guides for your discussions with your students. Present these concepts by means of the teaching techniques you feel are most appropriate.

Egocentricism

Students who are in elementary school are typically self-centered or egocentric. They tend to think about their own welfare and often forget to consider how their behavior affects others. Although we understand this tendency, most teachers agree that one purpose of education is to broaden students' range of interests. Environmental education is an ideal part of the curriculum for expanding students' interests to include other people, other species, and to recognize how their behavior affects their world.

Our general goals for environmental education are to increase students' knowledge about and concern for other cultures, other species, and future generations.

Other Cultures

Teaching students about other cultures is included in our environmental program because environmental problems do not recognize traditional state or national boundaries. For example, air pollution in the United States affects people in Siberia. Water pollution upriver also affects people and animals who live downriver. If people are concerned only about their own, immediate surroundings, they tend to forget how their actions may affect others in distant parts of the world. Our goal is to help students be aware of the far-reaching, global impacts of environmental problems, and how all countries are affected by them.

Other Species

Students usually enjoy learning about animals and want to help take care of them. When students learn about life cycles and the web of life, they begin to realize how interrelated our lives are with other animal and plant life. Protecting our environment must include protecting animals and plants.

Since the beginning of our world, many species have become extinct. Extinction seems to be part of the rhythm of nature. However, in the last 200 years this rhythm has increased drastically. In other words, the total number of extinctions that occur in this century may be ten times greater than that in the seventeenth century. Technological man seems to have greatly accelerated the rate of extinction for many species. As environmental educators, our goal is to make students aware of the importance of all life forms and the ethical problems when man carelessly disturbs their habitat.

Future Generations

Most environmental programs emphasize resource conservation. For example, we encourage students to recycle paper products, to turn off lights, and to keep thermostats turned low during cold weather. Students may think that the main reason for conserving natural resources is monetary. Our job as educators is to help them understand that there is a more important reason for conserving. Since fossil fuels cannot be replaced (for thousands of years, anyway), once they are used they are gone forever. Future generations may not have any oil or coal unless we care enough to conserve those almost irreplaceable fuels.

The general concept underlying conservation is that natural resources should be used sparingly so that future generations will continue to benefit from them. If we can encourage students to be concerned with the future of our planet, we may increase their motivation for conserving. If their motives have previously been based on saving money, those students whose parents are wealthy may fail to understand the need for them to conserve. Conserving for future generations includes all economic classes. Our goal is that students will understand the necessity to conserve natural resources for future generations.

Specific Topics

There are some specific topics that are important to the three general goals that we have discussed. They include environmental impacts, pollution, energy, interrelationships, life cycles, and the quality of life. If students understand the implications of the first five topics, they may begin to realize that the quality of life includes all life, not just human life. We should also be careful to teach them that environmental issues are complex. Our decisions about how we can "save" the environment are not easily made and will require some personal sacrifice.

Review of General Goals

1. Students will understand that environmental impacts have global effects and will begin to think about how all different cultures are affected by environmental problems.

2. Students will understand the importance of [illegible] life forms and the ethical problems when man carelessly disturbs [illegible]eir habitat.

3. Students will understand the necessity to conserve natural resources for future generations.

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SHOPPING: AN ENVIRONMENTAL ADVENTURE

Objectives: Students will be able to 1) identify nonrenewable and renewable resources; 2) discuss the cost of recycling; and 3) discuss the long-term environmental costs of using products made from renewable and nonrenewable resources.

Background: Many of the objects that we use were once made of wood, but they are now made from nonrenewable resources, such as plastics from petroleum.

Materials: Worksheets for students.

Procedure: 1. Discuss the advantages of using products made from renewable resources instead of products made from nonrenewable resources.

2. What trade-offs are made when products are made from nonrenewable resources instead of renewable resources?

3. Discuss the idea that some products made from nonrenewable resources, for example, plastic cups, may be used more often than those made from renewable resources, such as paper cups. Does this fact justify buying plastic cups instead of paper cups? (Amortization)

4. What problems are involved in any recycling? (transportation costs, labor costs, energy to operate the recycling plant)

5. Is there a better choice than either of the two choices given? Either a different thing or a change in lifestyle?

WORKSHEET FOR
SHOPPING: AN ENVIRONMENTAL ADVENTURE

Given your choice, which of the items below would you choose to buy if you wanted to have the least impact on the environment? Circle one item in each row that you would buy.

Questions that you should consider when you mark your choices:

1. Is it from a renewable resource?

2. How much does it cost the environment to produce it?

3. How much does it cost to recycle it?

4. Compare how many times it can be used to the cost from the environment to produce it. Does this make a difference with some items?

5. What else should we all consider when we make choices such as these?

Item A	Item B
Bicycle	Motorcycle
Plastic toy	Wood toy
Aluminum canoe	Laminated wood canoe
Aluminum ladder	Wood ladder
Chain-link fence	Wood-slat fence
Milk in glass bottle (returnable)	Milk in paper carton
Polyester shirt	Cotton shirt
Metal baseball bat	Wood baseball bat
Plastic picture frames	Wood picture frames
Wall-to-wall carpeting	Wood floors
Paper towel	Cloth towel
Paper cup	Plastic cup
Plastic bags at grocery	Paper sacks at grocery
Can of applesauce	Apples

LAKE HIKE

1. As your group walks along the paths around a lake, ask them to name the animals that they see. Ask: What do these animals eat? Do they serve as food for other animals? What other animal eats the same food? What would happen if that food were destroyed? Name some possible things that could destroy their food.

2. A Chinese philosopher once asked, "Can you step in the same river twice?" Ask the students if they can step in the same lake twice.

   Our environment is constantly changing. When we take water out of a lake, or put a boat in a lake, we really do a great many things to the lake and to all the things that live in and near it. Discuss the impact of our behaviors on lakes and rivers.

3. Ask one person to throw a rock into the lake. Watch the ripples. Discuss how our actions have many impacts that are far-reaching. Ask ten people to each throw a rock into the lake. Discuss the increased impact. Compare the increased numbers of ripples to population growth and its impact on the environment.

   Population growth increases rapidly just as the ripples on the lake do. When population increases, the impacts on the environment greatly increase, too. Forests are destroyed to build housing developments, and that destruction means that animals' shelter and food are gone, so we have fewer animals as well as fewer trees. A larger population means that more cars are purchased so more gasoline, a nonrenewable resource, is used. More electricity has to be generated, creating more pollution and using more resources. Just as there is no stopping place, no end, to the ripples on the lake from ten rocks, so there is no end to the amount of impact that increased population has on our environment.

4. Have students look for animal tracks and signs (feeding sites, nests, or droppings). Explain that these are signs that can tell us what kind of animal has been in a particular area. The Indians were skilled in reading these signs because their livelihood depended on knowing them. Scientists need to read these signs so that they can learn more about animal habits--how many and what kinds of animals there are in an area, what they eat, and where they sleep. Hunters and trappers need to read these signs so that they can decide where to set their traps or stalk their prey.

   If animals leave tracks or signs of their behaviors, what kinds of signs or tracks do people leave in a forest? (foot prints, litter, broken branches, oil on the surface of the lake, tree stumps, etc.) Have students who are wearing sneakers notice the different kinds of tracks their shoes leave on the path.

5. Compare different forms of recreation as to the "tracks" they cause. (Photography, trail bikes, hiking, fishing, water skiing, etc.)

VISIT TO A CEMETERY

1. Ask students to read epitaphs. Some epitaphs indicate that the people thought that death was a natural process, and these usually are about the immortality of the soul. Others emphasize the pain and suffering of death, and these usually stress the mortality of the body. Ask students which attitude(s) the epitaphs in this cemetery seem to portray. Is there a difference how old the dead person was when he/she died?

2. Ask students to define recycling. The students' discussion will probably include paper, glass, and can recycling. Lead the discussion to include the amount of energy used in the recycling process. For example, if the recycling plant is a long distance from the product to be recycled, there are transportation costs, in energy and in dollars. Add to those costs the amount of energy needed to run the recycling plant, and the labor needed to transport and prepare the material to be recycled. There is usually a small margin of profit in money or total energy saved in any man-made recycling process.

   There are also some social benefits to recycling. It raises money for community groups and helps to decrease litter.

3. Discuss nature's way of recycling. Lead the discussion to include:

   a) Trees dying in the forest
      Dead or hollow trees provide homes for animals. As the tree decays, it returns minerals to the soil, making the soil more fertile. Sometimes people use dead trees for firewood. The firewood provides heat for cooking or for homes, saving of non-renewable resources like coal, oil, or gas. Other dying and decaying plants are natural fertilizers that enrich the soil.

   b) Dead animals
      Since animals contain a large amount of protein in their bodies, as they decay they add a large amount of nitrogen to the soil, making them an important, natural fertilizer.

   c) People buried in a cemetery
      Indian burial customs were different from ours. In some tribes, the dead person was wrapped in a thin burial cloth and buried in a shallow grave. The rest of the tribe knew that the decaying body would fertilize the soil so that more grasses would grow. With more grasses to eat, the buffalo and other animals would flourish. Since the Indians depended on the animals, especially buffalo, for their food, clothing, and many other essential items, the Indians prospered when the animals prospered. When Indians killed a buffalo, they realized that part of their ancestors dwelled in that buffalo. They understood the natural cycles of life--natural recycling.

Compare the Indian story to our burial customs. Do our dead relatives add to the environment? Are they "recycled"? How much energy is used in making caskets, vaults, etc.? Would it be socially acceptable to bury our relatives like the Indians? (Remind the students of how population density makes the Indian burial customs less acceptable for us.)

FOODS IN OTHER LANDS

Objectives: Students will be able to 1) generalize regarding types of food that are eaten in several different cultures; and 2) discuss trophic levels.

Method: Students look at lists of foods that are eaten in several different cultures and divide the foods into plants or animal products.

Materials: Lists of foods that are eaten in several different cultures.

Procedure: 1. Discuss food chains and trophic levels. Explain that there is more food in plant form than animal form, and it is less expensive in both economic and ecological terms to eat plants than it is to eat animal products.

2. Give each student a worksheet describing the food that is eaten in several different cultures.

3. Ask students to put a "P" beside each food that is of plant origin and an "A" beside each food that is an animal product.

4. Ask students to find out how many kilograms of food each group of countries eats that come from plants and how many kilograms come from animal products.

5. Compare answers. Discuss the differences in the diets of the different cultures, what it implies about their lands, and why these diets have evolved.

Extension: In developing countries, the average diet is 2,000 Calories per day, 10% of which is of animal origin. In industrialized countries, the average diet is 3,000 calories, 33% of which is of animal origin. Discuss how this difference may be related to income levels, and how more people can be fed at less cost if they eat food from plants instead of food from animal products. The general rule is that the world (or any land area) can support ten times as many people who eat exclusively vegetables as people who eat exclusively meat. One choice that we have deals with whether we prefer a world with a small population of meat eaters or a large population of vegetarians.

Listed below are the number of calories of animal origin that are eaten in various parts of the world.

Country	Calories of Animal Origin
North America	1,324
Africa	141
Latin America	443
Western Europe	1,102
Near East	236
Asia & Far East	124
USSR	792

WORKSHEET FOR
FOODS IN OTHER LANDS

People in other countries around the world often eat foods that are different from the kind of food that we eat in the United States. However, all foods can be divided into food that comes from plants and food that comes from animals. On this page you will find a list of foods that people in different parts of the world eat. The numbers are the amount of kilograms of that kind of food that people in that part of the world eat every year. (A conversion chart from kilograms to pounds is provided below as a point of interest.)

CONVERSION CHART

kilograms	pounds
1.0	2.2
1.5	3.3
2.0	4.4
2.5	5.5
3.0	6.6
3.5	7.7
4.0	8.8
4.5	9.9
5.0	11.0

	North Amer.	Africa	Lat. Amer.	West. Europe	Near East	Asia & F. East	USSR
Cereals	90	138	127	124	186	194	207
Starchy Roots	55	177	101	88	23	26	120
Sugar	56	9	44	40	19	29	41
Meat	110	13	37	68	15	5	49
Eggs	18	1	5	13	2	1	9
Fish	11	7	7	18	2	8	19
Whole Milk	157	19	59	91	25	16	163

1. Add the columns on the list to find out the number of kilograms of food that are eaten by people in different areas of the world. (You may use this piece of paper to add the numbers.)

2. Look at the list of foods. Beside each food that comes from plants, put a "P". Beside each food that comes from animals, put an "A".

3. Add the kilograms in the "P" or plant category for each area of the world.

4. Add the kilograms in the "A" or animal category for each area of the world.

5. Are you surprised by the differences between the kinds of food eaten? Discuss the differences with your teacher.

ASTRONOMY

Objectives: Students will be able to 1) find the North Star; and 2) use it to determine the latitude of a place where they are located currently.

Method: Students will go outside on a clear night. They will use a protractor and a pointer to get the latitude of their current location.

Materials: Protractors and pointers (pencils or sticks).

Procedures: 1. Discuss latitude with students.

2. Help students find the North Star.

3. Ask students to hold the flat part of a protractor in a horizontal position. Place the end of a pointer on the flat part of the protractor. The pointer must cross the center of the protractor. Move one end of the pointer so that it is pointing to the North Star. Have a friend read the number of degrees on the protractor where the pointer crosses the protractor scale. That number is the latitude of the place where they are standing

4. Ask students to pretend that they are at the North Pole. The latitude of the North Pole is 90. Ask them to use their protractors to find out where in the sky the North Star would be if they were really at the North Pole. (The pointer should cross the center of the protractor and one end of the pointer should point overhead.)

   Discuss the differences in climate, vegetation, houses, etc. between degrees latitude at their current location and 90 degrees latitude.

5. Ask students to look for cities in the United States that are on the same latitude as their current location.

6. Ask them to find cities in other countries that are on the same latitude as their current location.

7. Ask students to find the latitude of their home town(s) and a place where they would like to visit.

A STAKE IN THE LAND

Objectives: Students will be able to 1) give examples of countries with especially high and especially low population densities; 2) generalize on how population density may be related to wealth and poverty; and 3) relate human population density to the more general concept of carrying capacity.

Background: The generalization is often made that crowded countries are poor countries. The major purpose of this activity is to add depth to students' understanding of why this is often true--and why there are notable exceptions. Central to the students' gaining new insights from this activity is their gaining deeper knowledge of the concept of social and biological carrying capacity.

Materials: Stakes or tent pegs and 8 differently colored flags for marking the corners.

Method: Students observe and discuss sample plots that illustrate population densities (i.e., land area per capita) for selected nations.

Procedure: 1. Select an area that is large (approximately 1 acre or the size of a football field), relatively flat, and free of obstructions (trees, buildings, etc.).

2. Using stakes, tent pegs or other markers, designate the area per person for selected countries. (Consult the figures on the next page for this information.) Do this in such a way that the common corner for all of the areas is at a convenient gathering place for the students. If feasible, mark three corners (all except the common corner) of each square with colors that are unique for that square.

3. In sequence, smallest to largest square, indicate which nation is represented and discuss basic information about each.

4. Using the country with the most dense population, ask students to sit on the boundaries of the square and discuss space allocation in that country. How much space would be necessary for
   a) growing food?
   b) housing?
   c) parks, wildlife habitat, wilderness, schools, rare plants, cemeteries?

5. Gather the whole group and discuss the ways that increasing human population tends to make things better and worse.

Country	Density Per Square Kilometer	Suggested Size for Areas
U.S.S.R.	12	95 feet
U.S.	25	66 feet
Kenya	32	58 feet
Mexico	38	53 feet
China	111	31 feet
United Kingdom	229	22 feet
Japan	317	18 feet

Extensions: Students should use geography references to find out more about the country they choose, especially the natural resource problems with which it is faced. Discuss ways in which people can change carrying capacity for themselves and for other animals. Discuss the most serious results of a nation's becoming crowded with people. Discuss some of the more basic connections among population density, wealth, and poverty.

For example, the positive aspects might include better economies of scale, (roads, power lines, sewers, etc. serve more people per mile), there are more hands to do work, and more geniuses alive at one time. The negative aspects might include the tendancy to crowd out other creatures, the tendancy to eliminate parks, wilderness areas, and large yards, reduces the freedom to roam, yell, hunt, etc. The worst aspect of a dense population is that options for a better future are lost because many resource decisions are irreversible. For example, if all of the whooping cranes are gone, the gene pool will be destroyed forever.

CAVES

Food Chains: Most caves have little or no sunlight except near the entrance(s). This feature of caves has significant impact upon the food chains that can function within the cave. Because of the lack of sunlight, few, if any, primary producers (green plants) can exist. So—what serves as the base for the food pyramids?

There are at least two answers. Sometimes underground streams can carry green plants (such as algae) into caves, and sometimes bats go outside the cave to feed. The bats' droppings inside the cave function as a fertilizer on which some insects and other invertebrates can feed, and on which some nongreen plants can grow.

Bats: When people walk through caves, they often frighten bats. The frightened bats fly around the cave. If it is winter, the bats use up some of their energy that they have stored to maintain them during the cold months. If they are disturbed often, they will die because they have consumed their limited amount of stored energy and cannot feed again until insects are available in the spring.

Do Caves Breathe? Oxygen comes in from the opening of the cave. Although the cave may be deep underground, its temperature is still affected by the outside temperature. During the day, when the temperature is warmer, the air inside the cave is also warmed, causing it to expand. When the outside temperature drops, the air inside the cave cools and shrinks, creating a vacuum, which sucks fresh air in. Thus, the caves "breathe".

Activities: 1. Take students into a cave that is totally dark. Wait for their eyes to adjust to the darkness (as much as they can). Ask the students to wave their hands in front of their faces and try to count their fingers. If they say that they can see them, ask another student to hold a few fingers in front of the "seers" to determine if they can count someone else's fingers. If the cave is really dark, they will not be able to do so.

2. Ask students to hum as they walk, with arms extended, toward a wall of the cave. Does the sound change as they approach the wall? (It should increase very slightly in pitch.) Why? (Because moving forward creates a shorter echo return time. If the students back away from the wall as they hum, still facing the same wall, the sound will decrease in pitch.) This change in pitch is similar to the way bats navigate by sonar or echo location. Their system is just more refined than ours. (The fact that they move faster also helps.) Discuss with the students the differences between people's and bats' sensory perceptions. Incidentally, bats are not blind, but their sonar is much better than sight for most of their night time activities.

MATH

Objectives: Students will 1) use multiplication and division to answer math problems that are relevant to environmental issues such as food chains, food waste, and water waste; 2) discuss those issues; and 3) practice their chart reading skills.

Method: Students will use their math skills to answer questions about their own food waste, water usage, and other environmental questions.

Materials: Math worksheets.

Procedures: 1. Discuss with the students the implications of the problems that they are solving.

WORKSHEET FOR MATH

A Farmer's Silo

1. If a beef steer eats about 60 bushels of corn in one year, and a farmer's silo holds 4320 bushels of corn, how many steers can the farmer feed from his silo each year?

2. If the corn in the silo were fed to people instead of to steers, it could feed 10 times as many people as steers. How many people could be fed from the silo that holds 4320 bushels of corn?

Firewood

3. There are about 6,000,000 Calories in a cord of firewood. One pound of good firewood contains about 2,000 Calories. Weigh two pieces of firewood. How many pounds does each one weigh?

4. How many Calories are in each piece of firewood?

Water Use

5. Another way that we can help the environment is to cut down on the amount of water we use. The chart below tells you about how much water you use when you wash, take a shower, or flush a toilet. Can you remember how much water you used yesterday?

Activity	Water Used
Flushing toilet	6 gallons
Shower	7 gallons per minute
Faucet left running (Brushing teeth, etc.)	3 gallons per minute

How can you cut down on the amount of water you use? Will you?

Cost of Electricity

6. Most of the electricity we use comes from burning fossil fuels. If we learn to save on the amount of electricity that we use, we can help save some of our fossil fuels for future generations. The chart below tells you about how much money it costs us to use some of the things in our homes.

Item	Cost
hot water	40 cents for each tank of water
toaster	2 cents for 2 pieces of toast
oven	4 cents for 1 hour
color television	3 cents for 4 hours
clothes dryer	16 cents for 1 hour
radio	2 cents for 6 hours
dishwasher	5 cents for one load
vacuum cleaner	1 cent for 20 minutes

The Smith family wrote down how much they had used some of these items. By using the chart above, decide how much money the Smith family spent on these items in one day. How much money does your family spend each day on these items? Is it more or less than the Smith family? Does your family have more or less environmental impact than the Smith family?

SMITH FAMILY		MY FAMILY	
Item	Use	Item	Use
television	4 hours		
hot water	2 tanks		
clothes dryer	1 hour		
oven	2 hours		
toaster	8 slices		
vacuum cleaner	20 minutes		
dishwasher	1 load		

SILO

Objectives: Students will 1) use math skills to estimate the height of a silo; and 2) have an opportunity to compare different methods of measuring height.

Procedures: 1. Divide the students into four groups.

2. Explain to the students that they are going to use four different methods to estimate the height of the silo. (The four methods are outlined below.)

3. After the groups complete their measurements, they should compare their answers.

Methods of Measurement

1. Shadow: Students can measure themselves, their shadows, and the silo's shadow. Next, they should multiply their height by the silo's shadow. Divide this answer by their own shadow. The answer to this division problem should give them an estimate of the height of the silo.

2. Gravity: Using a stopwatch, students should carefully time (to the nearest tenth of a second) the descent of a rock gently dropped (do not throw the rock) from the top of the silo. Next, they should multiply that number (the time) by itself (square the number) and then multiply that number by 16. Their answer should be a good estimate of the height of the silo in feet.

3. Multiplication: Students should find the height of a single band at the base of the silo and multiply that height by the total number of bands in the silo.

4. Similar triangles: One student with a yardstick should walk at least 100 feet away from the silo. Hold the stick vertically at arm's length and slide it through his/her hand until the portion of the stick above the hand just matches the apparent height of the silo. That is, when he/she sights with one eye, the top of the stick appears to be at the top of the silo and the top of the hand appears to be at the bottom of the silo. This first student should turn the stick horizontally, keeping the hand in the same location on the stick. The top of the hand should be in line with the center of the silo at its bottom.

A second student who is at the base of the silo should begin to walk away from it in the same direction that the first student's stick is pointing. The first student, still sighting with one eye and with head held in the same position, should direct the second student to continue walking until he/she appears to be at the end of the yardstick. When the first student calls out, "Stop!", the second student should remain in that spot.

A third student can now measure the distance from the silo to the second student. This measurement is an approximation of the height of the silo.

ORIENTEERING

Objectives: Students will 1) learn to use a compass accurately, determining azimuths or compass bearings; and 2) learn some significant ways in which the azimuths can help us understand natural phenomena.

Procedures: 1. Looking at the horizon, get a compass bearing on an imaginary point directly below the sun at noon, at 1:00 p.m., and at 2:00 p.m. Record each of the three bearings.

2. Ask students how far in degrees the sun moves in one hour? (15 degrees) How far does the sun move in twenty-four hours? (360 degrees) Encourage students to figure out how to solve this: If the sun comes back to approximately the same position in the sky by this time tomorrow, and it travels about 15 degrees per hour, how far has it traveled? (24 X 15 = 360)

3. Was the sun nearest to North, South, East, or West at noon? Answer the same question for 6 a.m. and 6 p.m. Is the sun ever north of us? (Not in this hemisphere)

4. Find a ridge running generally east to west. Mark an area approximately 1/4 of an acre on the north side and on the south side of the slope. Make a chart comparing the two areas or quadrats. (Ideas to look for: type(s) of ground cover, estimated soil moisture, air temperature, variety of trees.

5. What general conclusions about north and south aspect can you reach? Where would snow melt soonest? Where would ferns be most likely to grow? Where would deer be likely to go to rest during the hottest portion of a summer day?

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